

N. L. H. KRAUSS

THE RAFT BOOK

LORE OF THE SEA AND SKY

By Harold Gatty

*"There are more things in heaven and earth, Horatio,
Than are dreamt of in your philosophy."*

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Keep it wound and have it running on Greenwich (England) Time, which you can get from the navigating officer.

Keep track of the date at *Greenwich*; and, on a 24-hour basis know whether the time is, say, 6 hours (6 A.M.) showing on your watch, or 18 hours (6 P.M.) Greenwich.

PROTECT YOUR WATCH. GET A RUBBER SACK
FOR IT (OBTAINABLE FROM PHARMACIST) AND KEEP IT DRY
KEEP A PENCIL IN YOUR POCKET

POSITION OF SHIP WHEN ABANDONED

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South which one)

LONGITUDE degrees° minutes' East "
West "

GREENWICH DATE Month Day

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The Polynesians, greatest navigators of all time, made voyages back and forth in the Pacific between small islands thousands of miles apart. The knowledge of how they did this, without instruments and without charts, has never before been explained. After years of research, Harold Gatty, the navigator of the Post-Gatty "Round the World Flight" in 1931, has completely solved the question and presents in this book the simple and effective methods of the Polynesians for the use and benefit of those who need to find their way at sea.

With this book and enclosed charts, no instruments other than a stick and a piece of string, and no previous knowledge of navigation, persons who find themselves in small boats or rafts anywhere in any ocean or sea in the world can find their way to land. Born though it was of war, this book contains a wealth of information on the lore of the sea and sky that will be of the greatest interest and value to fishermen, sailors, and yachtsmen.

To one who doesn't know, the ocean may seem a vast, empty and unfriendly place. Actually, the sea, the life in it, its behavior, its appearance, and the sky, are full of aid and information if he will but take advantage of the information contained in this book. With the knowledge Harold Gatty has compressed into this book, the open sea, anywhere in the world, is a friendly place, full of life, and the means of maintaining and saving it.

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THE RAFT BOOK

LORE OF THE SEA AND SKY

BY HAROLD GATTY




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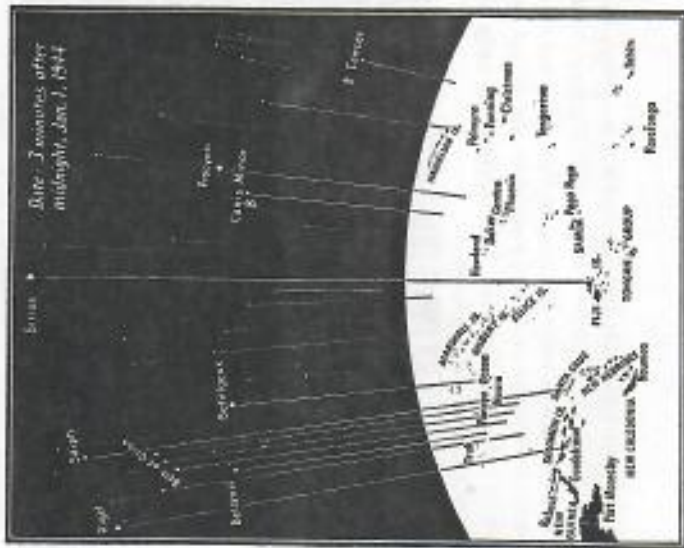
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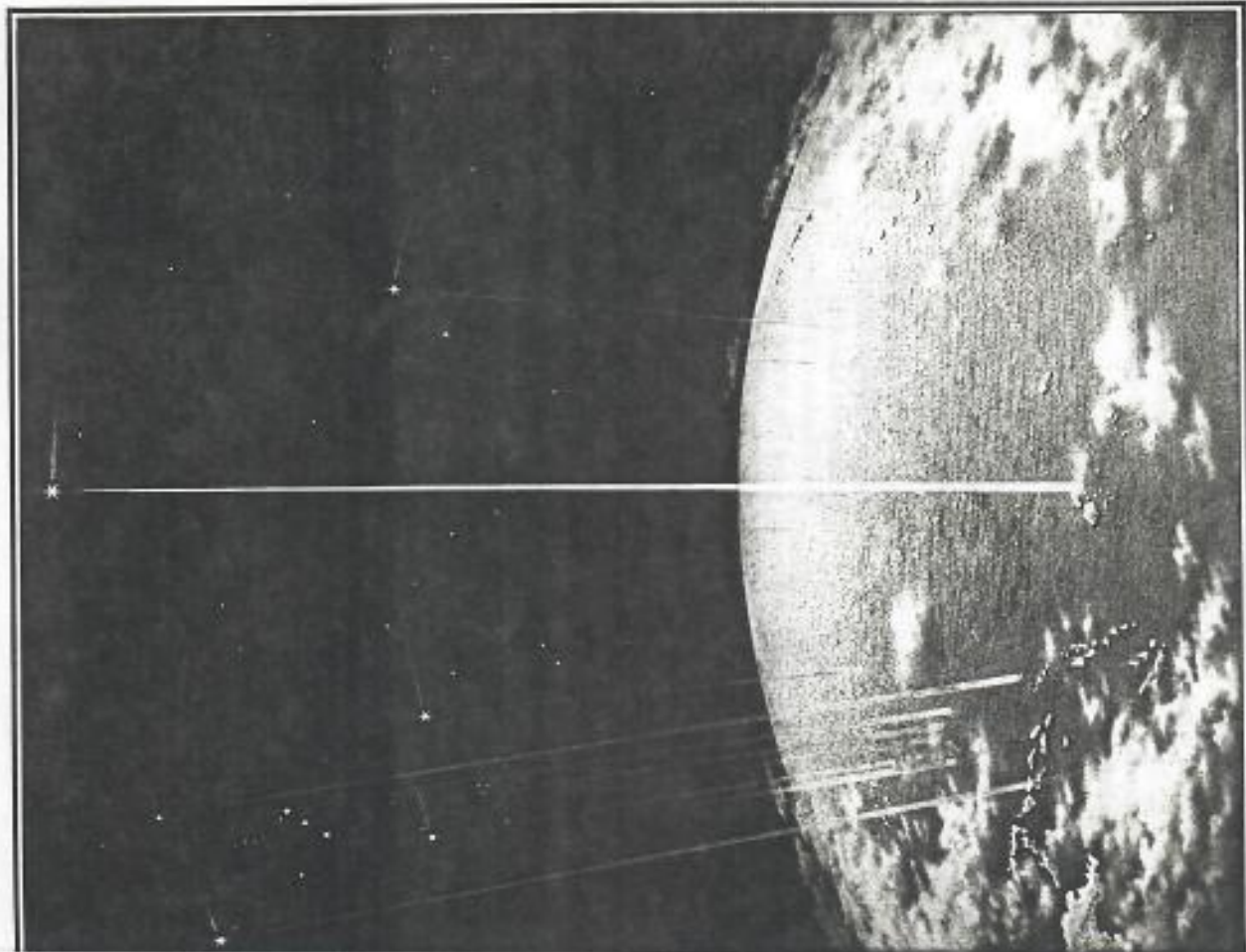
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The Polynesians viewed the stars as moving bands of light passing over the same islands night after night. They knew the stars which passed over particular islands, and used these stars as heavenly beacons to lead them to their destination.

The frontispiece showing stars over the southwest Pacific illustrates a specific instance of the use of Sirius as an overhead star for Vanua Levu of the Fiji Islands. The stars are in their actual positions for 3 minutes after midnight local time on January 1st 1944 (about 4 minutes earlier on each succeeding night).

The above diagram gives the names of the islands in the frontispiece, and the names of the easily recognizable stars which are overhead at the same time in these islands.



*The sun sails down on Tama's path, across the changing sky;
New stars do leap above the deep to meet the wondering eye;
New seas are spread on every side, new skies are overhead;
New lands await the seafarers, in the vast grey seas ahead.*

MAORI SONG. (After Best)



INTRODUCTION

This book has been written for those who, without previous experience in navigation and without navigating instruments, find themselves in small craft in the open sea and who have to make their way to land.

The methods contained in this book include the simple and effective means that enabled primitive peoples to travel across the oceans, as well as other ways that have been devised at the present time to fit your particular problem.

It has been definitely established that primitive peoples had no more "sense of direction" than we have. Realizing this, and following their time-tested methods, you can have full confidence that you can find your way as well as, or better than, they could.

Many others before you have made long and successful voyages in very small boats and rafts. Just because the methods of the Polynesians are frequently mentioned throughout this book, it should not be thought that these methods apply only to the Pacific Ocean. These great seafarers happened to populate the Pacific, but they could have navigated equally as well by the same means in the Atlantic.

Several new applications of old ideas have been worked out and are included here. The use of a watch with the simple methods given in the book will enable you to fix your position in an east and west direction (longitude). There are also a number of methods in this book for obtaining your position in a north and south direction (latitude).

However, it is of the utmost importance that you carry a watch kept running on Greenwich Time. All persons who are sailing the

The author gratefully acknowledges the assistance of the following: C. R. Taylor, Librarian, Alexander Turnbull Library, Wellington, New Zealand, and officials of the Auckland Museum, New Zealand, for help over many years in research in Polynesian navigation; my friend Louis Reynolds who gave so much of his time and assistance; Dr. Robert Cushman Murphy, Curator of Oceanic Birds, American Museum of Natural History, for valuable advice, corrections of the bird data herein, and permission to use extracts from his works; John Treadwell Nichols, Department of Fishes, American Museum of Natural History, for advice and data for the section on Fishes; Captain Karel Weersma, for long and tedious calculations of the tables. Appreciation of the valuable assistance, in all parts of the book, of my good friend Dr. Dana Coman, cannot be adequately expressed.

seas or flying over the seas in these times, should have their watches set on Greenwich Time for their own safety.

With reasonable rations, even though you are far at sea, you should have no worry about reaching land. There are simple ways described in this book to fit all circumstances.

Following are important suggestions which should be closely adhered to:

1. If you know where you are when you board your craft, mark the position and the time on your Base Chart accompanying the book.
2. Keep track of your course and speed as best you can.
3. Keep as regular a course as possible without unduly exerting yourself until you are sure of the direction of land. You have every chance of being picked up if you just keep your head and *conserve your strength*.
4. Knowing your position and the direction to the nearest land does not mean that your best way is necessarily a direct course. Let the winds and currents help you. The longest way round is sometimes the shortest way home.
5. Do not let the direction of the wind at the moment be the basis of your decision. Study the wind, current and water temperature charts on pages 70-81 and from the resultant winds and currents make your decision as to the most advantageous course to follow.

This book is given with the idea that it should be read, if possible, before any emergency arises. It is hoped, however, that the information and suggestions it contains will justify carrying it at all times for repeated reference in helping you to find your way to land.



LORE OF THE SEA AND SKY

Present day navigators are apt to place so much reliance on mechanical and tabular aids that we sometimes forget that primitive peoples were able to voyage over a large part of the world without any such devices. A study of these primitive methods shows that there are many valuable aids we have neglected or forgotten, and that a continued reliance on mechanical aids places us in a very helpless position when deprived of them. In the lore of the sea and the sky one can still find those fundamental and simple means which gave early man confidence and enabled him to find his way on the trackless sea. The earliest navigators of history—the Phoenicians, the Arabians, the Vikings and the Polynesians—all used very much the same basic methods but applied them differently.

In addition to the basic methods common to all the early navigators, the Polynesians had many unique and superior means; for this reason much of the material here presented deals with the art as practised by them. Having originally migrated from the west coast of India, the Polynesians peopled islands over the length and breadth of the Pacific. Unlike continental races whose migratory urges never took them far from shores, the Polynesians were an oceanic people and were forced to develop the art of direction finding at sea to a high state of perfection. Under the compulsion of economic pressure, tribal differences, or trade in semi-precious greenstone, the Polynesians made extensive sea voyages throughout this vast area and maintained frequent intercourse between groups of islands thousands of miles apart.

When one realizes that all of the habitable islands scattered over the Pacific Ocean in a triangular area of approximately 4,000 miles

on each side extending from the Hawaiian Islands to Easter Island (2,000 miles off the coast of Chile) and to New Zealand, roughly constituting what is now known as Polynesia, were settled by one people, of one culture and one language, it should be conclusive evidence that the Polynesians were without doubt the greatest pathfinders in history. The back and forth voyages between Tahiti and New Zealand over a distance of 2,500 miles are a matter of history, as are also the voyages between Tahiti and Hawaii over a similar distance. The last of these voyages was made about the year 1350 A.D. when a considerable fleet from Tahiti permanently colonized New Zealand. The last of the colonizing voyages to Hawaii had ended about a century previously.

There is very little, if any, difference between the problems confronting a Polynesian voyager in the open ocean far from land and those of the occupant of a raft or life-boat; each must rely on his ability to determine his position and the course to the nearest land without the aid of modern navigating instruments.

You are in a much better position to solve the problem than the Polynesians were, because you are equipped in this book with additional simple and practical ways and means of locating and guiding yourself ashore.

Any system of navigation is a combination of a number of methods, each of which must be used at the appropriate time. This is just as true today as it was a thousand years ago. The direction finding methods of the Polynesians have not been easy to reconstruct; for aside from the fact that they had no written language, they kept their system of navigation as a very jealously guarded secret in the hands of the Tohungas, or priests. This placed the men who knew their way about the ocean among the most powerful members of the tribe, since it gave prestige second only to the chief, and entitled considerable material advantages.

In order to learn their methods, it has been necessary to look carefully into their legends and the accounts of early white ex-

plorers in the area, and gradually piece together the essentials of their system. Because students of primitive culture are not usually navigators, a complete understanding and interpretation of the Polynesian system of navigation has not previously appeared.

Having spent the greater part of my life in the South Pacific, with the opportunity of extensive research in primitive navigation, I am satisfied that solely by use of these same methods anyone in any ocean can find his way to land.

The Micronesians, inhabiting the many small atolls of the Caroline and Marshall groups, to the northwest of the Polynesian area, are people of a distinctly separate wave of migration and are of part Mongoloid origin.

Most of their methods for finding position on the high seas are identical with those of the Polynesians, but in addition they evolved a system of charts particularly suited to the conditions throughout their scattered groups. As with the Polynesians, their means of finding their way was kept a closely guarded secret. It was not a monopoly of the chiefs' families, but more the secret of certain intelligent individuals who, with marked powers of observation, were especially trained in this art, and, in turn, transmitted it to similarly gifted members of their families. Like the Polynesians, the Marshall and Caroline Island navigators enjoyed special privileges usually reserved for the chiefs. They were permitted to walk on the weather side of an island, and they possessed very high social standing together with the advantage of the use of more land.

It is interesting to note that a century after the last of the great Polynesian colonizing migrations, we read of the pre-Columbian navigators of Europe still being afraid to venture out beyond the Pillars of Hercules into the Green Sea of Darkness, the Atlantic.

MIGRATORY BIRDS AS WINGED PILOTS

Birds have played a far greater part in the opening up of the world than is generally realized. It is the writer's conviction that man has been led across the water to other lands by migratory birds.

A study of the tracks of the migration of land birds in the Pacific, and further consideration of the evolution of bird migration routes, shows that man's path in the Pacific has followed the paths of land birds. No people, whether primitive or civilized, would set out over thousands of miles of ocean without knowing that they were going to some land. The Polynesians, who were, like all primitives, close observers of nature, saw the land birds taking off year after year in the same direction, and knowing that they were not able to rest on the ocean, must certainly have realized that another land lay in that direction. What else would lead these seafaring people from Tahiti to New Zealand but the repeatedly observed migration of the Long-tailed Cuckoo between these two places?

In such migration flights, the Long-tailed Cuckoos do not all set out at once, but straggle over a period of two to three weeks, the young ones taking off first and the older ones later; and, since their flight level is never very high some part of the migratory flock can always be seen by day or heard by night.

The Polynesians setting out to follow such a migration route took a careful departure by lining up range marks on the shore previously determined from the flight of the birds. Having once made the voyage and observed the many other indications along the route, they eventually needed the birds no longer and voyaged back and forth with perfect confidence.

This same condition applied between Tahiti and Hawaii, along one of the tracks of the Golden Plover which migrates between Alaska and Tahiti. As Wells Cooke, of the U. S. Biological Survey, has suggested in "The Book of Birds" by Henry Henshaw, there has been an evolution of the migration routes of birds in the Pacific

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as there has been on the American continent, where the Golden Plover has, over a period of centuries, shortened its tracks. This latter far flying bird, many centuries ago, may have taken a path from the northeastern tip of Siberia down the Asiatic coast through the East Indies and a little south of the Equator to Tahiti and the Marquesas; along the very path from the East Indies across the Pacific as followed by the first Polynesian stream to these groups. At a later period, the route of bird migration from Siberia is thought to have been from the Kamchatka Peninsula through the Japanese Islands and by way of the Caroline and Marshall Islands to Tahiti.

The second Polynesian route was through these Micronesian Islands. A later, and in fact, one of the several present day routes of the Golden Plover is from Alaska through Hawaii to Tahiti. It is believed that the Hawaiians were led to their islands from Tahiti by these same birds. In a like way, I believe that the original inhabitants of New Zealand, who were Polynesians with mixed Melanesian traits, came to New Zealand from Polynesian settlements in the vicinity of the Solomon Islands, following the migratory track of the Shining Cuckoo.

I have dwelt on this to stress the fact that the flight of birds was very closely watched by these oceanic people. Like all primitive wanderers, they realized the great value of noting the flight of birds as a means of finding direction.

☆ ☆ ☆

MIGRATION OF INSECTS

Butterflies or other insects are sometimes seen hundreds of miles out at sea; hence, they should not always be taken as an indication of being close to shore. It has been established that some of them

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migrate very long distances over water. Moreover, the direction of their flight is apparently little influenced by the prevailing winds since they have been observed in enormous numbers flying against the wind just as often as with it.

During migratory flights, butterflies rarely fly as high as 100 feet and hence are always easily seen. Unlike migrating land birds, whose direction of flight is always from one point of land to another, only the direction from which the butterfly has come is of any value in determining the direction of land. Butterflies are known to cover several thousands of miles in their migrations. It is definitely known that they do not migrate for food, for their mass flights take them into many unfavorable places such as out to sea, across the ocean or towards the Arctic regions where they perish. As an aid in pointing towards land, the only clue to be drawn from the migration of butterflies when seen at sea is that they have come from land.

Although the direction from which migrating insects are coming points towards land, any one such indication alone is rarely entirely reliable of itself, but should be correlated with all other observations denoting land. It has been recorded that a single stable fly alighted on a small vessel which was still fifty miles off the southeast coast of the United States. This would not of itself be positive evidence of the proximity of land; yet, correlated with other equally suggestive findings, it would strengthen the probability of land nearby.

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LAND SIGHTING BIRDS AS NAVIGATING INSTRUMENTS

Shore sighting birds, carried by all primitives, when released, made their way to the nearest land. This was a method common to the

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Phoenicians, the Arabian navigators of the Indian Ocean, the Vikings in the Atlantic, and the Polynesians and Micronesians in the Pacific.

The story of the deluge in Babylonian and Hebrew literature describes the well-established use of shore sighting birds. When Floki, the Norse navigator, left the Shetlands for Iceland, he carried a number of Sea-Ravens (probably Shags). A few days out, one of these birds was released. It circled for altitude and seeing land stern flew towards it, thus giving Floki a back bearing on his point of departure. Several days later, a second bird being released returned to the vessel after circling and seeing no land. Eventually one of the birds, upon being released, took a forward course to Iceland which indicated the final direction to their destination.

The Frigate (or Man-of-War) Bird was the shore sighting bird of the Polynesians and being plentiful in these regions, was always available. Although an oceanic bird, it does not normally land on or take off from water. Even in recent times, Frigate Birds have been used as message carrying birds between the islands.

On Ocean and Nauru Islands in the central Pacific, Frigate Birds are still kept as pets but probably because the native voyages have ceased, the islanders have forgotten the origin of the custom.

The most adaptable bird for shore sighting would appear to be the trained pigeon, and there seems no reason why such birds could not be carried in lifeboats and in rafts. Upon being released a pigeon would circle for altitude and either go to land, or, if no land were in sight, would return, and enter its cage again.

If two birds were carried, the first bird could be released, and after noting the direction which it took to the nearest land, the second bird could be dispatched with a message giving the bearing. If carried, these "feathered instruments" would at least be available for food if not used as messengers. Even the corn with which to feed them need not be wasted.

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LAND INDICATIONS FROM SEA BIRDS

*He who, from zone to zone,
Guides through the boundless sky thy certain flight,
In the long way that I must tread alone,
Will lead my steps aright.*

To a Waterfowl—BRYANT

One of the most important ways of telling when you are near land and in what direction it lies, is by carefully noting the flight of sea birds. There is nothing very difficult about this if the main bird types can be recognized.

Each area of the ocean has its own characteristic temperature, depth, salinity and movement, and thus its own particular marine life. It is this marine life which determines the type of bird found there, and, hence, by identifying the birds that you see you will know many things about the area in which you find yourself.

Robert Cushman Murphy, in his authoritative work, "Oceanic Birds of South America," states:

"... if the quality of the water may tell us something about the birds, the birds should also tell us much about the water. The Snow Petrel requires water which is cool; Tropic Birds prefer water which is clear, dense, saline and moderately warm; the Brown Booby clings to water inhabited by flying fish which, in turn, are limited to water of definite temperature and gaseous content."

He goes on to say that in the Tropical Zone the relative scarcity of oceanic bird life contrasted with conditions in cooler latitudes, is very striking. In general, the majority of tropical sea birds do not range far from their breeding grounds on islands, island groups and continental coast lines. The presence of man, animals or other natural enemies on the larger islands reduces the bird population, but on the small islands in the Tropical Pacific and Indian Ocean, where the birds are not disturbed, they breed in large numbers.

One observer making a long cruise in the Tropical Pacific recorded an average of only one bird for every 125 miles of open sea. In fact, one may travel for days across tropical oceans and see no

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birds at all. If you are in such an area, do not let this discourage you for there are many other ways of locating yourself that you can use. It will be realized then that the value lies in watching for the *increase of birds* and the *presence of certain birds* as an indication of approach to land.

Another observer on a voyage between San Francisco and Tahiti noted that for the first two days North American coastal birds were seen, after which for five or six days he saw only an occasional petrel. Nearing the Equator, when scattered woolly clouds became thicker and grayer, the swell increased, rainstorms came and suddenly numerous birds appeared. Among these were Storm Petrels and Red or White-tailed Tropic Birds; then, as islands were approached, large numbers of Terns were seen. As the ship proceeded farther along the birds dropped away as abruptly as they had first appeared.

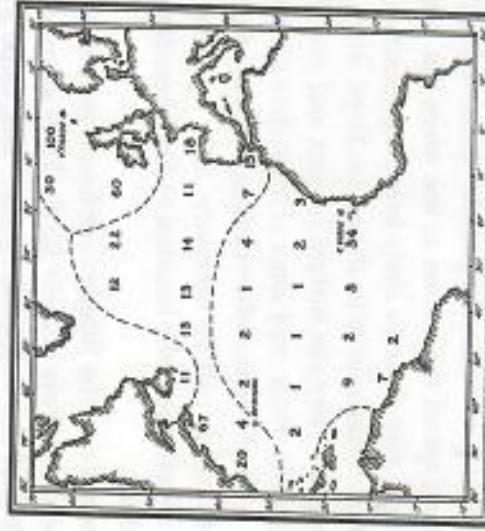
This sudden appearance and disappearance of bird life in the Doldrums or when passing from one current or ocean area into another shows what different conditions may be found in neighboring waters. One locality may be rich in its ability to support bird life, which conditions may be entirely lacking in another area nearby. Such change in bird life is strikingly seen at the meeting of one current with another where an upwelling of the cooler water from the depths brings food to the surface. An example of this is where the Gulf Stream meeting the Arctic Current causes extensive eddies and contrasts.

Far from land, especially in the tropical regions, sea birds are very scarce, and this is where you may need them most for food. All sea birds are edible and are not difficult to catch provided you have a fishing line and can float a baited hook. The Albatross and other hook billed birds may be caught with a shiny metal object that will catch in their bill. Other birds will dive and gulp any hook baited with a bright rag or suitable object.

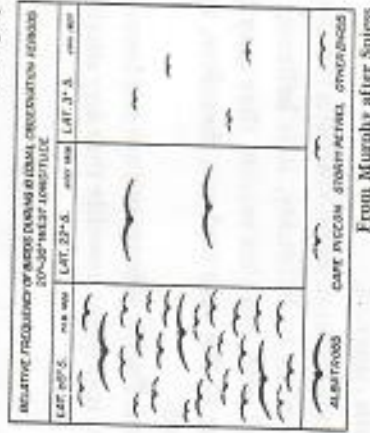
The flesh of sea birds and fish may glow in the dark but is still good to eat.

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The top chart of the North Atlantic shows the average number of birds seen per day. We note that 100 birds were observed daily around the Faroe Islands, only 1 per day in the middle of the Atlantic, 4 in the vicinity of Bermuda and 34 around the Cape Verde Islands.



Alter Jespersen



It is interesting to note that on a line between Bermuda and the south of Spain, 1 bird per day was seen in the middle of the Atlantic, increasing to 4, 7, and 15 as Gibraltar was approached.

The lower diagram for the South Atlantic shows that an increasing number of birds appears as one goes south of the Equator.

HABITS OF SEA BIRDS

The habits of a representative number of sea birds are given as a general indication of their value in determining the vicinity or direction of land. From pages 24 to 33, plates and accompanying descriptions of 43 species of sea birds will be found.

The illustrations by the eminent bird artist, Francis L. Jaques, are drawn so that the distinctive features of each species may be easily recognized. After recognizing a bird from the plates and description, a glance at the table summary, "Land Indications from Sea Birds" following the identification plates, will show what may be deduced from observations of a particular bird. Reference should be made to the distribution, breeding places, and dates of breeding at the back of the book, pages 141 to 152, for a more certain indication.

It will be noted that at different times of the year, according to whether birds are breeding or not, their habits, and therefore their importance as indicators of land, will vary accordingly. The tabled summary is given as a general guide. It should be borne in mind that there will be exceptions, and that the art of finding land is made up of many evidences, which when put together, result in more certain assurance of the distance and direction of land.

General information on the habits of the families comprising the 43 representative species, which is intended to augment the tabled summary, follows.

ALBATROSSES

See plate 1 and pages 24, 241, 242 for further data.

The albatross sleeps on the water, and like a number of other oceanic birds drinks salt water, thus never having need to seek land except in the breeding season.

It is not difficult to catch. One method which I have used successfully off the south of New Zealand is to trail a small open triangle of brass on the end of a line. The albatross, attracted by the shining

metal, gets his curved bill caught in the triangle. It is then an easy matter to haul him gently aboard, after which he becomes violently seasick. If you do catch one, watch your hands because this bird has a very sharp bill. The strong, hooked bill is common to all albatrosses.

There are thirteen known species of the albatross family. Nine of these are found in the southern oceans, three in the Northern Pacific, and one which breeds in the Galapagos Islands off the northwest coast of South America.

Although the greater number of Southern Hemisphere albatrosses breed from December to February, it is believed that they breed only every second year. For this reason, they may be found far out at sea at any time of the year and are, therefore, at no time a sure indication of land.

When the North Pacific albatrosses are not breeding, that is, from April to October, it is quite possible that any small number may be a long way from land.

PETRELS

See plates 1, 5, and pages 24, 32, 142, 143, 148, 149, 150 for further data.

The family which includes the petrels, shearwaters, fulmars, and the Cape Pigeon spend their time at sea when not breeding. The majority of them stay close to their breeding grounds, but others migrate from one hemisphere to the other. Even when at sea, they like to congregate. They are surface feeders and may be seen very often skimming the water, and some of them dive for food. In order to derive any value from the observations of birds of this species as indications of land, it will be necessary, after identifying them, to refer to their distribution, the location of their breeding places, and dates of breeding.

It will be noted that the fulmars are found only in the Northern Hemisphere and are truly oceanic birds. They are one of the most numerous birds of the northern oceans. The Cape Pigeons, also oceanic birds, are found only in the southern oceans. These noted ship followers may be seen far from land. They will be found in far

greater numbers close to land even in the season when they are not breeding, and it is by the observation of these birds in great numbers that deductions may be reached that land is close by.

The sight of a considerable number of the shearwaters during the summer breeding season in either hemisphere may indicate that they are flying to or from land on daily fishing trips. Most of the shearwaters migrate long distances, but are usually limited to within 200 miles of coasts when not migrating. The tabled summary will show that some of the species of the shearwaters do not go as far to sea on their daily fishing excursions as others.

The storm petrels are ship followers and may be seen a long way out from shore except during the breeding season. Wilson's Storm Petrel is usually an indicator of the Gulf Stream when seen in numbers in that vicinity.

The observation of increasing numbers of any of the petrel family certainly indicates proximity to one of their island breeding places, where they may be seen off shore in hundreds, and in certain places, many thousands. Single birds or small numbers of petrels, even during the breeding season, may be far from land and spend the night on the sea, but this will not be the case with larger numbers.

BOOBY BIRDS AND GANNETS

See plates 2 and pages 26, 243, 244 for further data.

These birds, which breed in such large numbers on oceanic islands, are always good indicators of land.

All of the booby and gannet families are great fishermen and may be seen, especially in the early morning, departing from land on their way to their fishing grounds. They usually return to their nesting places in the late afternoon with full bellies of fish for their young, retaining any balance for later digestion; that is, if they can avoid the Frigate Bird on the way back. Should you, as happened to the writer, find yourself stranded on a barren island where these birds are found, a supper of quite edible fish may be obtained by

LAND INDICATIONS FROM SEA BIRDS

Bird No. Plate	Name of Bird	Localities and Dates Page No.	Time of Year	Number Seen at One Time	Reasonable Assumption
5	Other Shearwaters, Southern Hemispheres, except Short-tailed Shearwater	150	December to February	3 or more 15 or more	Within 200 miles Within 100 miles. Direction of flight at dawn and dusk gives direction of land
5	Sooty Storm Petrel	150	Remainder of year January Remainder of year	Any number 6 or more 3 or less	May be far from land 100 miles May be more than 200 miles off shore
5	Red Phalarope or Northern Phalarope	150	June-July August- November February-May December- January	3 or more Any number Any number 3 or more	75 miles May be far from land (migrating) May be far from land (migrating) 75 miles
5	Tufted Puffin Horned Puffin Common Murre	150, 151	Any month	3 or more 6 or more	Within 150 miles. Direction of flight at dawn and dusk shows direction of land 70 miles. Direction of flight at dawn and dusk shows direction of land
5	Brunnich's Murre (similar to Common Murre)	151	May and June Any month	Any number Increasing numbers	Limit of 200 miles, and then off Grand Banks Show proximity to land
5	Guillemots Auklets	151, 152	Any month	1 or more 6 or more	50 miles 25 miles

FISH AND OTHER SURFACE LIFE

Surface life is an indication of the character of the sea water and may thus help you recognize some well known current or area of the ocean such as the Gulf Stream, Humboldt Current, Equatorial or Counter-Equatorial Current; for in passing from one region to another there are very noticeable and characteristic changes in the marine and bird life.

In the open ocean far from shore one does not find the rich life frequently thought typical of these deep waters. The marine forms encountered are apt to be limited to whales, porpoises and the few particular types of ocean-ranging fish described below.

Rather than attempt to describe the countless different forms of coastal fish, we list below only those fish found far at sea, and which are few in number. These deep sea fish are given so that they may be eliminated as indications of nearness to land. Any other forms are likely to be coastal varieties.

Deep sea fish may at times be seen close to the shore, but the coastal fish, especially in any numbers, will not be found far at sea.

BLUE SHARK

This slender frequenter of the warm seas is the only shark usually found far out from land. Most other sharks stay close to shore. The Blue Shark, found in tropical waters throughout the world, is of a deep to bright blue color. The average adult is about 12 feet in length but some reach as much as 20 feet.

Most sharks are accompanied by pilot fish swimming freely alongside of them wherever they go. The pilot fish which accompany the



Blue Shark, however, differ from the pilot fish found with the coastal sharks. The Blue Shark's pilots are as round as cigars and

LAND INDICATIONS FROM SEA BIRDS

Bird Plate No.	Name of Bird	Localities and Dates Page No.	Time of Year	Number Seen at One Time	Reasonable Assumption
2	Brown Booby	144	Any month	1 bird (only 1 case recorded - Caribbean Sea) 3 or more 6 or more	150 miles 75 miles Usually within 50 miles May be far from land 50-80 miles
2	Tropic Birds Red-tailed Red-billed White-tailed	144	Any month	1 or 2 3 or more	May be far from land 50-80 miles
3	Frigate Bird	144, 145	Any month	3 or more 6 or more	100 miles Within 75 miles. The direction of flight of even 1 bird at dusk generally points to land, as they never sleep on the water
3	Comorants	145	Any month	Any number	25 mile limit
3	Penguins	145	Any month	Any number Increasing numbers	May be far from land throughout the year - except when breeding Show approach to breeding places
3	Brown, or Other Pelicans	145	Any month	More than one Increasing numbers	25-mile limit; usually made less Show approach to land
3	Great Skuas	145, 146	Winter months either hemisphere Summer months either hemisphere	Increasing numbers Any number	Show proximity to land May be far from land
3	Jaguers	146	July-October August-September	Any number Any number	Far out Close to land (north of Arctic Circle)
4	Herring Gull and all other Gulls except the Kittiwake	146, 147	Any month	3 or more Increasing numbers	50 miles (or within the 100-fathom line off coast) Show approach to land

LAND INDICATIONS FROM SEA BIRDS

Bird Plate No.	Name of Bird	Localities and Dates Page No.	Time of Year	Number Seen at One Time	Reasonable Assumption
4	Kittiwake	147	April-July August-March	6 or more Any number	Close to shore. Within 50 miles May be far at sea
4	Black Skimmer	147	Any month	1 or more	Within 25 miles
4	White Tern	147, 148	Any month	1 or more	Within 40 miles
4	Arctic Tern	148	May-July December-February Remainder of year	6 or more 6 or more Any number	(Arctic)-close to shore within 100 miles (Antarctic)-close to shore within 100 miles May be far at sea
4	Noddy, Sooty and other Terns, except White Terns	148	Any month	Any number	May be far at sea
5	Divling Petrels	148, 149	July-November Remainder of year	6 or more Any number	Within 75 miles May be far at sea
5	Storm Petrels in Southern Hemisphere	149	December-February Remainder of year	6 or more Any number	Within 75 miles May be far at sea
5	Storm Petrels in Northern Hemisphere	149	June-July Remainder of year	6 or more Any number	Within 75 miles May be far at sea
5	Greater Shearwater	149	Beginning of October to middle of May Remainder of year	6 or more Any numbers Greater numbers Smaller numbers	100 miles May be far at sea Inshore Far out
5	Manx Shearwater	149, 150	March to June July to February	3 or more 12 or more Increasing numbers	Within 200 miles Within 100 miles. Direction of flight at dawn and dusk gives direction of land Show proximity to land

LAND INDICATIONS FROM SEA BIRDS

Bird No. Plate	Name of Bird	Localities and Dates Page No.	Time of Year	Number Seen at One Time	Reasonable Assumption
5	Other Shearwaters, Southern Hemispheres, except Short-tailed Shearwater	150	December to February	3 or more 12 or more	Within 200 miles Within 100 miles. Direction of flight at dawn and dusk gives direction of land May be far from land
5	Sooty Storm Petrel	150	Remainder of year January Remainder of year	Any number 6 or more 5 or less	100 miles May be more than 200 miles off shore
5	Red Phalarope or Northern Phalarope	150	June-July August- November	3 or more Any number	75 miles May be far from land (migrating)
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Blue Shark, however, differ from the pilot fish found with the coastal sharks. The Blue Shark's pilots are as round as cigars and

have black cross bands, while the coastal sharks' pilot fish are flat. The Blue Shark is excellent eating and not difficult to catch, provided you have heavy enough tackle.

Some sharks have a great deal of ammonia in the flesh and are inedible unless the ammonia is removed by washing or drying out. If the flesh is sliced into small pieces, towed astern for a few hours and then dried out, it should be edible.

A simple method of catching sharks still used by Samoans is to hold some bait in the water near the bow of the canoe while a large noose is held over the side amidships. The shark, attracted by the bait, comes alongside and swims through the noose towards the bait. A sudden tightening of the noose around its middle is followed by a quick heave on the line by several natives. In this manner the shark is hauled bodily into the canoe and is quickly clubbed to avoid upsetting the craft.

Trailing the foot as shark bait is not recommended, but, with other bait lacking, it has proved successful. It will be realized, of course, that there are limitations to what can be tried in a rubber boat or life raft. Handling a fish that may be up to 12 feet in length requires common sense as well as a stout line.

If you can catch the shark, you can catch the pilot fish. You may also find Remora fishes which attach themselves by a sucking disc on the top of their heads to the under surface of the shark's throat. Remoras reach a length of 1 to 2 feet.

If luck comes your way and you catch a Remora you can put it to good use by keeping it alive. Taking care to keep your hands away from its razor-like gills, tie a line securely onto its tail. Now turn the Remora loose and give him as much line as you can spare. He will fish for you and attach himself to any shark or turtle or large fish that comes in his range. After he is stuck on, haul them both in. Repeat this until you or the Remora gets tired. This is not a "fish story" but is common practice among native fishermen in the tropics.

BLUE WATER PORPOISE

There is only one really deep sea porpoise and it is found in the warm waters of all oceans. It is somewhat smaller than most of

the coastal types and has an irregularly shaded grayish body averaging about five or six feet in length.

Usually seen in large schools, it can be readily identified by its habit of jumping clear out of the water. All other kinds of porpoises are usually coastal. The porpoise is edible but difficult to catch except by harpooning. The shoulders provide the best steaks.



SUN FISH

This large fish, which sometimes reaches a size of 10 feet and a weight of 2,000 pounds, is found in most of the temperate and tropical seas of the world, and can be frequently seen in calm weather far from land lying flat on its side and gently moving its fins. Although mostly found near the coasts, it may often drift far out at sea and should not necessarily be taken as a sign of land close by. The flesh of the Sun Fish is said to be poisonous; however, the Japanese consider the liver a delicacy.



OCEAN BONITO

This is the only bonito found far from shore. Other species of bonito are sometimes found 25 miles off the coast, but rarely, if ever, beyond 50 miles. Striped lengthwise on its under surface as distinguished from coastal bonito, this fish is aptly called the Watermelon.

It is one of the fish most frequently seen in the warm waters of all oceans where it operates in small schools preying on flying fish. It reaches a length of about 2 feet and a weight of about 20 pounds. Bougainville, in 1768, put to good use his knowledge of the gen-

eral localities in which certain types of fish are found. His crew had caught a bonito, in the stomach of which was a small fish of a species found very close to the shore. Bougainville's inference from this that there was land nearby was borne out the next day by the discovery of four islands.

DOLPHINS

These fish, found in all the warm blue oceans, travel in schools and are the greatest enemy of the flying fish. Having somewhat flattened sides, their bodies are elongated, tapering gradually from shoulder to tail. They reach a length of 6 feet but a fair average would be 3 or 4 feet. Dolphins are oceanic fish and in no wise indicate nearness to land.

The Dolphin is probably the fastest swimming fish in the ocean. In vivid blues and yellows it is one of the most brilliantly colored of all fish. It can be caught from

any moving craft on a hook set in a piece of wood with a white rag attached. If the lure is barely allowed to touch the water and jerked into the air and made to imitate the action of a flying fish, the Dolphin will usually strike. Around any logs, cases, barrels and other drift found in the open ocean, young Dolphins 4 to 12 inches long will usually be found. They can be caught with a baited hook.



FLYING FISH

Although very welcome as food, Flying Fish are of no value as a sign of land for there are about 20 to 30 species, some of which are coastal and some only met with on the high seas. They are quite easily caught at night by holding a light, mirror, or any available glittering object in front of a shirt, sail or other obstruction.



SARGASSUM FISH

Known also as the Gulf Weed Fish, the Sargassum Fish is practically the only fish seen in the vast, deep, blue and deserted waters of the Sargasso Sea. It is a small fish, about 6



inches in length and is hard to distinguish from its surroundings, for in shape and color it has the appearance of a piece of the sargassum weed in which it hides. While the Sargassum Fish itself is not edible, considerable quantities of small crabs and shrimps will be found attached to the weed. By lifting pieces of weed up and shaking them, any amount of sustaining food may be procured.

OCEAN PIPE FISH

Many of the pipe fishes are found among coastal sea weed, but the Ocean Pipe Fish ranges from the Mediterranean to well within the eastern limits of the Sargasso Sea; where, in about latitude 35° North and longitude 42° West, it is found together with the Sargassum Fish. It averages about 9 or 10 inches in length and is very slender with an elongated tubular snout. Like the Sargassum Fish, the Pipe Fish has practically no value as food.



SKIPPER

Young fish of this species, just a few inches long, are plentiful in the Atlantic Ocean between about 12° and 40° North latitude. The older fish reaching from 14 to 30 inches in length are flat, silvery fish, and usually swim in large schools. These fish can be caught and are edible.



LANTERN FISH

Living at great depths in the ocean are a number of species of small, silvery fish among which are the Lantern Fish. They have long slender bodies, are very fragile and are usually under 6 inches in length.

They have large eyes to make up for the lack of light in the deep waters, and have luminous spots on the under-side of the body. Lantern Fish stay far down in the daytime but in the cool of the evening in calm weather they frequently follow the twilight to the surface. Though small, Lantern Fish provide a possible source of food when at the surface at night in calm weather far from land.



BLACK RUDDER FISH

All along the North Atlantic coast from Cape Hatteras northwards and occasionally off the coast of Great Britain, around any floating wood, Gulf Weed or other drift, the Black Rudder Fish congregate. They are often found in company of jelly fishes. The Black Rudder Fish reaches a length of approximately 13 inches and a little over a pound in weight. Eating this fish is not recommended.



TRIGGER FISH (*Leather Jackets*)

There are many coastal species of Trigger Fish but some species are found far out at sea. They will often congregate around any

drifting craft and have a peculiar habit of rolling over on their sides and appearing to stare at you. They are quite easily caught with hook and line and are good to eat.

In the Atlantic they are rarely found north of the Gulf Stream.



SEA SNAKES

One species of Sea Snake is common in the waters around Panama, but most members of the family are found along the coasts of the Indian Ocean, the East Indies, the Philippines, and the waters of the Western Pacific and Northern Australia.

They differ in appearance from land snakes in that the tail is vertically flattened and paddle-shaped. They vary from 3 to 8 or 9 feet in length.

Sea Snakes are all poisonous and some of them are among the most venomous of all snakes. Actually not many people are bitten by them as Sea Snakes usually go away if disturbed except during the breeding season on land when they are aggressive.

These snakes very seldom occur far from shore and are normally found within the 100 fathom line of the coasts and especially off the mouths of rivers. They feed on small fish or eels found along the bottom, and it appears that the depth to which they can go is limited to about 500 feet. As the 100 fathom line does not ordinarily extend far off tropical coasts "seeing snakes" will be a welcome sign to landing craft.

COMMON FLOATING FORMS

Found upon the waters of the open ocean are the beautiful blue Velellas. Commonly known as "by-the-wind-sailers," they may be seen in considerable numbers sailing even well into the wind, and very frequently hundreds of miles from shore. They are disc shaped forms of jellyfish about one to three inches in diameter.



The Portuguese Man-of-War is also of the jellyfish family. It appears as a crested, delicately pink and blue bladder-like form four to eight inches long floating on the surface and trailing long jelly-like threads. A very painful sting will result from handling them. They may be seen in considerable numbers a long way out to sea.



SEAWEED

A well known indication of land is seaweed, for it is usually a shallow water vegetation. On being detached it may be carried for some distance off shore by wind, currents, or tides. Thus, consideration should be given to the direction in which this plant life may have drifted away from its origin. It will be recalled that Columbus observed seaweed and other floating debris as he approached the West Indies.

In one particular region of the North Atlantic, the appearance of seaweed does not necessarily indicate nearness to land. This is the Sargasso Sea, an area of relatively stationary water 1,000 miles in diameter extending from 30° to 40° North and from 40° to 70° West. Here, encircled by the Gulf Stream on the west and north, and the Northeast Trade Drift on the east and south, are enormous beds of densely growing sargassum, similar to, but apparently quite unassociated with the coastal type of such seaweed.

The attention early seafarers paid to signs of nearby land is illustrated in the journal entry of Abel Janszoon Tasman, the famous Dutch navigator, in 1642:

"Towards evening, we again saw various lots of rockweed floating about, and observed large numbers of tunnies [bonitos] near and round about the ship; our boatswain's mate and one of the sailors also saw a seal from which we surmised that there may be islands hereabouts, since the said animals are not likely to go out far to sea; on this account we did not venture to run full sail."

In the Temperate and cool latitudes, any seals and sea lions observed, may, as Tasman remarked, be relied on as being very close to shore.

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THE SCENT OF LAND

The accounts of early voyagers all contain frequent references to the odor of land still beyond the horizon. One of them speaks of the odor of rosemary off the coast of Spain more than ten leagues out at sea. And one who accompanied Sir Francis Drake in the Pacific in 1577 writes:

"From hence wee directed our course towards the South-Southwest . . . at which time wee had a very sweet smell from the land . . . and wee had sight of the land about 3 of the clocke in the afternoon the same day."

Various parts of the world have their own particular odors. The smell of burning peat may be picked up many miles out at sea from the Falkland Islands as can the scent of the orange groves approaching the Cape Verde Islands, while the sweetish rancid odor of the drying coconut may be detected far out at sea in tropical regions. The penetrating odor of ammonia may betray the sea-bird roosts on small islands. The smell of bush or forest fires, factories, oil refineries, or other odorous industries, all indicate land not far off, as do the characteristic odors of beach or tidal lands, or the sweet smell of earth, especially after heavy rain.

I have personally experienced the fragrance of new-mown hay 80 miles off the New Zealand coast in the springtime.

The detection of any land odor, especially in fog, mist, rain, or at night when odors are usually stronger and are carried out to sea by the land breezes, is very important, for you may be drifting past

a nearby shore. The Polynesians on their long voyages frequently carried pigs with them and watched them closely, since having a highly developed sense of smell, they became excited on smelling land still far out of sight.

Odors are carried by the wind and therefore any new odor detected at sea should be considered a possible indication not only of the vicinity of land but of its direction.

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SOUNDS FROM LAND

Nature provided you with ears that you might hear. The fact that you have two ears not only enables you to hear but to tell the direction from whence the sound is coming. Sound often carries very great distances over water and, when other aids are lacking, may be very valuable in locating land. The distances at which sounds can be heard over water are, of course, affected by the strength and direction of the wind.

The roar of heavy surf may be heard long before the shore is seen. At night, the *continued cries of sea-birds from one particular direction* will signify their roosting place on land.

Among sea-birds, as distinguished from migrating land birds, the gulls are practically the only ones that make any noise when in flight. As the Kittiwake is the only gull that is found far out at sea and is restricted to the North Atlantic and the high latitudes of the northern Pacific, one may be safe in assuming that outside of these regions the sound of birds at night generally indicates land, or the direction of land.

It is possible that during fog or nighttime you may be close to a populated shore where the sound of trains, marine fog signals, factory whistles or other signs of industrial activity can be heard. If

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in fog and you hear a ship's whistle or siren, you may assume the vessel is moving; but if bells are heard at regular intervals the sound is either coming from a ship at anchor or from a bell buoy or other stationary marker. When close to high rock-bound coasts, especially in fog or during the night, one may judge the distance off-shore by firing a pistol or shouting and listening for an echo. This principle is followed by ships in the inland waterways of Norway, British Columbia, Labrador and Alaska, where the ship's whistle is used and the echo timed. As sound travels at the rate of 1,100 feet per second (5 seconds to the mile), distance offshore can be deduced from half the difference between the time the sound is emitted and the time it returns.

By shutting the eyes, it will be found much easier to concentrate on the direction from whence the sound is coming. By turning the head, in order to get equal volume of sound in each ear, it is possible to obtain a very close approximation to the bearing of the sound. By taking into consideration the type of sound and the velocity and direction of the wind it may be possible to judge fairly closely the distance of the origin of the sound. The cessation of the sound of waves breaking on shore may indicate the presence of an inlet or harbor.

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THE SKY AS AN INDICATOR OF LAND

Clouds were closely watched by the Polynesian navigators and were used in many ways.

The white sands of the coral atoll reflect more heat than does the surface of the surrounding water, causing a difference in the temperatures above these surfaces, which results in a small cloud hovering over the atoll.

It will not be directly overhead but a bit on the lee side due to

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the effect of the prevailing wind. The bright turquoise lagoon is reflected from the underside of the hovering cloud and can be observed by the navigator miles before these low-lying atolls appear above the horizon.

Even in the absence of any clouds, lagoons or other shallow waters will cause a reflection in the sky itself that is very conspicuous. Because light is lost in the depths, deep waters are poor reflectors and produce little if any such effect in the sky.

Matthew Fontaine Maury, the renowned American oceanographer, in his "Sailing Directions," speaks of hovering clouds being observed not only over coral islands but over shoals.

"They are often seen to overhang the lowest islet of the tropics, and even to stand above coral patches and hidden reefs, 'a cloud by day,' to serve as a beacon to the lonely mariner out there at sea, and to warn him of shoals and dangers which no lead nor seaman's eye has ever seen or sounded out."

The reflections from the ground or water, on the underside of the clouds can be used in many other parts of the world.

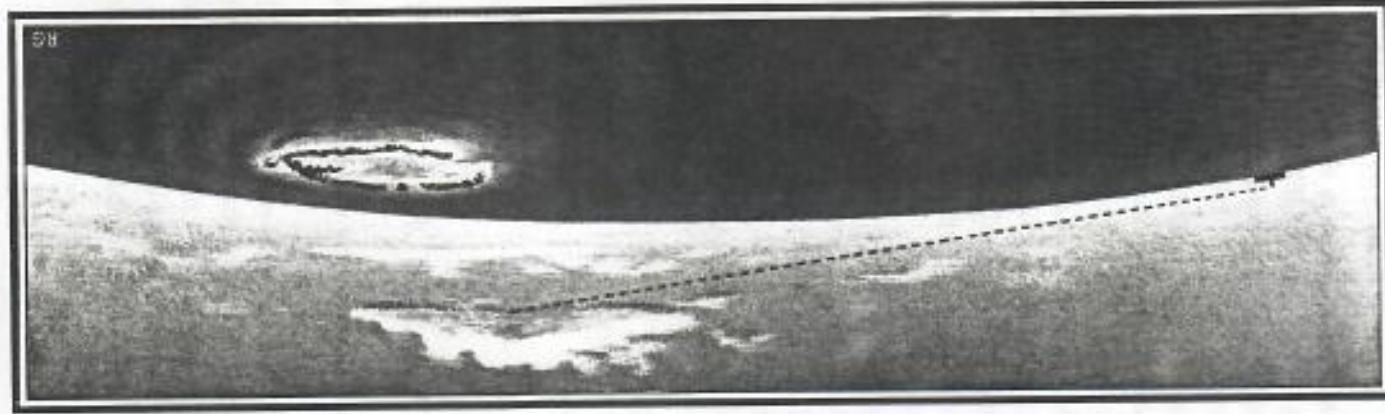
In Polar regions, the reflection from the surface results in what are known as "water skies" and "ice blinks" and which respectively indicate the lack or presence of reflecting surface.

A "water sky" is a sharply defined shadow in an otherwise bright sky, most clearly defined in low clouds, and indicates open water in the midst of ice. Conversely, an "ice blink" is a sharply defined patch of brightness in an otherwise gray sky and is a sign of areas of floe or shore ice in the midst of open water. Polar explorers have always paid considerable attention to these effects.

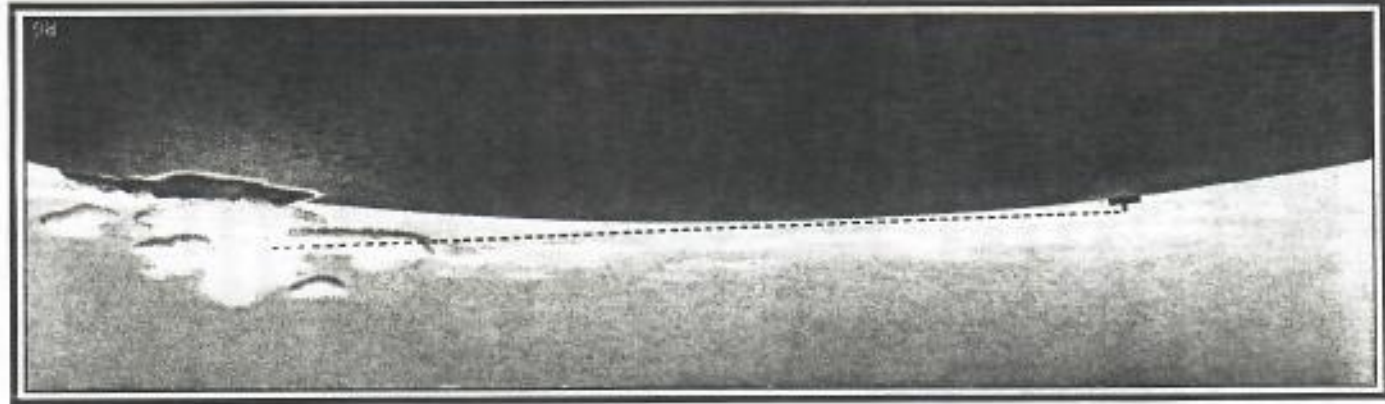
These indications in the sky, usually seen as reflections on clouds, can even be seen in a clear sky. This is illustrated in a desert region where the reflection of dazzling white sands is called "desert blink."

The light from cities can be seen at a very great distance as reflected in the sky, especially by high clouds and can be used similarly. Lighthouses may be seen even when far below the visible horizon, by the light reflected in the sky or by clouds.

PLATE 9



Color of lagoon reflected from cloud indicating an atoll beyond the horizon.



Fixed clouds around peaks with moving clouds passing by them, indicating land beyond the horizon.